



**White Paper in the Form of Frequently Asked Questions about Boundless’
Ultra Low Bandwidth, Indoor, Outdoor and Mobile, Digital Video
Surveillance System with Recording at the Edge**

Q1) What are the primary benefits of Boundless’ system ?

- solves the *backhaul problem* for video surveillance, providing **freedom of access**
- ultra low bandwidth system is IP-based from the ground up, and is highly optimized for efficient use over public and private, bandwidth-limited, wired and wireless, wide area, IP-data networks
- uses bandwidth-saving video on demand with near-camera recording (recording at the edge of the network) of many different digital video streams per camera, not bandwidth-hogging video streaming with central recording of a single video stream
- indoor, outdoor and mobile equipment provides rapid remote access to live and recorded video via wide area networks such as the Internet, and internally records higher quality video than can be continuously sent live to a distant video recorder
- multiple distant users can view live and recorded video simultaneously without affecting the quality of internally recorded video
- six to nine video streams for each camera, with different resolutions, frame rates, data rates and compression factors continuously, span a 100:1 range of data rates to serve a wide range of needs for image quality, viewing on various devices, network speeds, viewing over damaged or congested networks, and viewing recorded video at faster than real-time (up to 8X)
- optional **Transcode Broadcast Server** with **Rapid Event Notification System** provides live and recorded video (not just snapshots) in a browser on mobile and desktop devices, usually in less than 5 seconds from an event – without e-mail or text message delays, without requiring a mobile phone number or installation of a custom viewing executable, supporting team viewing by mobile task forces without burdening the video server’s uplink, satisfying Dept. of Homeland Security (DHS) initiative for open access, and providing a simple, web-based application programming interface for system integration
- geo-identified, geo-searchable, secure remote access to live and recorded video, and PTZ control, to video servers is optionally available in a web browser via Google maps
- video servers optionally transcode M-JPEG, MPEG-4, and H.264 video carried by HTTP and RTSP, from IP-cameras, into many different video streams simultaneously, enabling high quality, high bandwidth local wireless video, with bandwidth-limited backhaul
- optional revokable unique security certificate for each video server, and each viewing PC, and encryption of transmitted information, using OpenVPN, satisfying key requirements for Criminal Justice Information System (CJIS)
- optional encryption of recorded video in video servers with dynamic authentication, protecting recorded video from viewing if stolen

- solves routing problems, handling mobile-terminated (open ports or port-mappable) and optionally, mobile-originated (firewalled, non port-mappable) networks
- widely-tested, has been used with cellular networks on five continents, Inmarsat, Iridium and VSAT satellite networks, and WiFi, WiMAX and wireless mesh networks
- video servers use off-the-shelf computer hardware, Boundless' proprietary software, and Linux, providing a powerful, flexible platform that can run additional services
- VPN-based remote management and reporting system sends e-mail to a server-specific account for each video server when events, such as disk problems are detected, without requiring specific ISP information, and enabling Boundless to remotely make updates and configuration changes

Q2) What is Boundless' market focus ?

We believe bandwidth is precious. We are an original equipment manufacturer and specialize in outdoor and mobile, digital video surveillance systems for public safety and commercial applications over public and private, wide area networks.

Q3) Why not just stream video from an IP-camera to a distant network video recorder using a 3G or 4G cellular wireless network ?

It takes far too much sustained bandwidth – too many giga-bytes (GB) per month, not just kilobits per second (Kbps). If one had a wide area network that could support continuously streaming outdoor surveillance video with standard definition resolution of 640x480, 5 frames/second, and high sharpness for every frame, you would need about 512 Kbps using high performance video compression. That would require a network-crushing, **166 GB/month**, or worse – about 332 GB/month for 15 fps, far beyond the 5 or 10 GB/month that wireless carriers design their networks for. (Forget 1080p high definition, it would take 6x as much.)

Most contracts with cellular carriers allow them to **throttle** your bandwidth once you exceed the amount they consider reasonable. We believe the latest, fastest, WiMAX, and 4G and LTE cellular networks will encourage unsuspecting users of IP cameras to increase their use of continuous video streaming, but carriers' latest efforts to curb such abuses discourage this.

See “Verizon to Curb Highest Data Users,” by Roger Cheng, *The Wall Street Journal*, page B1, Feb. 4, 2011:

<http://online.wsj.com/article/SB10001424052748703652104576122030887519022.html?KEYWORDS=roger+cheng>

At a continuous 512 Kbps, you would exceed a relatively high, 10 GB/month allotment in just 2 days. Once throttled, your video would either stop or its quality would collapse.

Boundless avoids this problem, protecting the quality of recorded surveillance video. Since a typical Boundless' outdoor video server has two built-in PTZ cameras and continuous internal digital video recording of both cameras at 640x480, 15 fps, and 1024 Kbps, **Boundless avoids the need to send approx. 664 GB/month of video over the air** to a distant recorder.

Q4) What does Boundless mean by ultra low bandwidth ?

Uplink data rates as low as about 8 kilobits per second for live video at a resolution, frame rate and sharpness suitable for many smartphones. Downlink data rates are a small fraction of the uplink data rates. This traffic is only when the video is requested for viewing. There is also a small amount of continuous traffic to maintain name servers and VPN's.

Boundless has solved the “**backhaul problem**” of video surveillance. A “backhaul” is the long-distance portion of a wide area network, as opposed to the short distance portion of a local area network. Boundless' systems work where others don't due to bandwidth and routability issues. Boundless' systems can carry live video over congested and damaged, wireless wide area networks at data rates as low as 8 Kbps, with low resolution and frame rate, without affecting the much higher quality of video recorded within them. Higher resolution and frame rate, and sharper images, are available live when higher speed uplinks are available.

Bandwidth is the ability of a communications network to carry information. The higher the bandwidth, the more information can be carried per unit time. Bandwidth is often measured in Kbps – kilo-bits per second, or Mbps – mega-bits per second. Since we are talking about video surveillance, the higher the bandwidth, the higher the resolution and frame rate, and the greater sharpness for a given resolution, video can be carried live, in real time. While the downlink speed may be far higher, the uplink speed, the rate at which information can be sent to the Internet, of a cellular network is often about 250 Kbps, and varies widely and rapidly depending on how many other users are nearby and using the same network. This is significantly lower than the about 1 Mbps that a VGA (640x480)-resolution video stream at 15 fps (frames per second) that MPEG-4 and like compression requires for sharp images with moderate motion.

Boundless' system enables high speed wireless networks, such as cellular networks, to be used sparingly, in bursts, enabling the networks to be used by many users simultaneously, rather than to continuously stream the best possible video to a distant recorder, limiting the use of the network to a few and degrading it for everyone else. Boundless enables you to record high quality video surveillance continuously, in our outdoor equipment, from multiple cameras simultaneously, without streaming 100 GB or more per month per camera over the air. See Q3 for some examples.

Q5) What does Boundless mean by *many different digital video streams* for each camera ?

Boundless recognizes that there are different needs for different amounts of video at different times. We recognize the value of mobility. Commanders need to view many cameras simultaneously even on a wireless laptop in the field, to be able to assess a complex, rapidly evolving situation in a single screen from many perspectives, and direct a task force. Task force members, who may only be able to carry a smartphone, need to see one or a few cameras in a single screen.

Sometimes one needs a video stream that's optimized:

- a) for viewing live on a smartphone
- b) so you can view dozens of cameras live at the same time on a laptop PC or netPC in the field and thus via a wireless network
- c) for looking out from a moving vehicle or from a moving PTZ camera
- d) for the best possible recorded video for investigations, to try to read a license plate or get a mugshot
- e) for viewing live video from a vehicle when the vehicle is in the shadow of a building or a hill, and the cellular signal is weak, or when the cellular network is congested or damaged by a storm
- f) so multiple members of a task force can see the same video at the same time to coordinate their actions or prepare for engagement
- g) so you can view recorded video at faster than normal speed so you can review minutes of video in seconds without the speed of the uplink limiting how fast you can play the video, e.g., if the uplink is 250 Kbps and video is recorded at 250 Kbps, you can view it at 1X normal speed but not faster, whereas video that is recorded at 32 Kbps can be viewed at 8X normal speed
- h) so you can get a graph (not just a table) that accentuates the relative amounts of motion over time and quickly review many recorded video clips to decide which ones are interesting and merit further attention

For each camera, Boundless statically and continually creates as many as nine different digital video streams, with different resolutions, frame rates, data rates and compression factors, to handle this wide range of viewing and communications requirements. The video streams typically span a 100:1 range (not percent) of data rates. The ability to remotely view live video is limited by the speed of the uplink from the video server, while the ability to remotely view recorded video is not, it just takes longer if the uplink is slow. All video streams are recorded internally and are available remotely, and are also available remotely live if uplink bandwidth from Boundless' video server permits.

Here's an example of the different video streams that are often configured *simultaneously* for each camera, and are available remotely live if uplink bandwidth permits, and also recorded:

- 1) 160x120, 1 fps, 8 Kbps (this would be 2.6 GB/month per camera if streamed continuously), and
- 2) 160x120, 5 fps, 32 Kbps (this would be 10.3 GB/month per camera if streamed continuously), and
- 3) 160x120, 15 fps, 64 Kbps (this would be 20.7 GB/month per camera if streamed continuously), and
- 4) 320x240, 5 fps, 64 Kbps (this would be 20.7 GB/month per camera if streamed continuously), and
- 5) 320x240, 15 fps, 128 Kbps (this would be 41.5 GB/month per camera if streamed continuously), and

6) 640x480, 15 fps, 1024 Kbps (this would be 331 GB/month per camera if streamed continuously)

Note: The data rates above are *nominal-not-to-exceed*, which means Boundless' video server tries not to exceed the stated value. The actual data rate depends on the amount of motion in the scene, detail in the scene, and camera noise. With the exception of the highest data rate stream, whose every single frame is sharper than in the other video streams and the actual data rate usually closer to the stated data rate, the data rates may be only 1/3 of the data rates stated when there's little motion and good illumination.

For example, suppose Boundless' video server has a 256 Kbps uplink, a speed that is available from many 3G cellular networks. With Boundless' system, one can remotely access at least:

- 1) two, 320x240, 15 fps live streams at 128 Kbps each, or
- 2) four, 320x240, 5 fps live streams at 64 Kbps each, or
- 3) four, 160x120, 15 fps live streams at 64 Kbps each, or
- 4) eight, 160x120, 5 fps live streams at 32 Kbps each, or
- 5) thirty-two, 160x120, 1 fps streams at 8 Kbps each, or

6) or a combination that adds up to 256 Kbps, with the added benefit that low motion streams require less than the stated nominal-not-to-exceed data rate, in which case more streams can be viewed simultaneously than stated above, or

- 7) a stream recorded at 32 Kbps at 8X normal speed

Note that one person viewing live video from four cameras simultaneously from the same video server at 64 Kbps per stream requires the same amount of bandwidth, 256 Kbps, as four persons viewing the same video stream, each at 64 Kbps. We have broadcast servers that enable multiple users to see the same video stream at the same time with only a single load on the uplink.

Another example of the use of these many different video streams is viewing many cameras simultaneously on a PC using our viewing software. There's no point wasting network bandwidth, or the cpu power of the PC, decoding and displaying more video than can be displayed. For example, suppose your laptop has a screen resolution of 1280x800. Of this, about 1020x750 is available for video, allowing for the menu bars of our viewing software.

One could display one video stream with 640x480 and a magnification of about 159%. Or, one could display four video streams simultaneously, each with 640x480 and a magnification of about 79%, thus not being able to display 21% of the resolution. But it would be more efficient to display four, 320x240 video streams, each at a magnification of 159%.

Likewise, if one wants to view sixteen video streams simultaneously, one could, if there were sufficient bandwidth, memory and cpu power available, view sixteen, 640x480 video streams, each with a magnification of only 40%, not being able to display 60% of the resolution. Or, one could view sixteen, 320x240 video streams, each with a magnification of 80%, not being able to

display 20% of the resolution, a far more efficient solution, one that requires less than 1/4 the bandwidth, memory and cpu power.

If one wants to view thirty-six video streams simultaneously, one could, if there were sufficient bandwidth, memory and cpu power available, view thirty-six, 640x480 video streams, each with a magnification of only 26%, not being able to display 74% of the resolution. Or, one could view thirty-two, 160x120 video streams, each with a magnification of 106%, a far more efficient solution, one that requires less than 1/16 the bandwidth, memory and cpu power, and can be run even on an inexpensive NetPC rather than requiring a powerful workstation.

Q6) Why not just have one recorded stream and one, lower quality, live stream per camera, as many IP-cameras do ?

It's not enough choices, as explained in the previous question.

Q7) Why not pull M-JPEG video from an IP-camera for viewing in a browser ?

First, it assumes the camera can be accessed as a server, which is not possible if it's behind a firewall. Second, it takes too much bandwidth, especially when there are multiple viewers.

Q8) What are some block diagrams that describe Boundless' system ?

http://www.boundlesssecurity.com/documents/BoundlessSecurity_Ultra_Low_Bandwidth_Wireless_Video_Surveillance_for_Mobile_Task_Forces.pdf, or <http://preview.tinyurl.com/6cljpa7>

http://www.boundlesssecurity.com/documents/BoundlessSecurity_Pole_Dual-Camera_System_for_Amber_Alert_Video_for_Small_Towns_Using_Cellular_Network.pdf, or <http://preview.tinyurl.com/6gbm5tb>

http://www.boundlesssecurity.com/documents/BoundlessSecurity_Transcoding_Outdoor_View_Pole-Mounted_Wireless_Video_Surveillance_Base_Station.pdf, or <http://preview.tinyurl.com/6dbglu3>

http://www.boundlesssecurity.com/documents/BoundlessSecurity_Ultra_Low_Bandwidth_Ultra_Low_Power_Solar-Powered_Outdoor_Digital_Video_Surveillance_System.pdf, or <http://preview.tinyurl.com/2bmo23v>

http://www.boundlesssecurity.com/documents/Boundless_Remote_Digital_Video_Surveillance_of_27_Cameras_at_10fps.pdf, or <http://preview.tinyurl.com/4abwzpz>

Extensive information can be found on:

www.BoundlessSecurity.com >> Police / Govt

www.BoundlessSecurity.com >> Wireless

Q9) Isn't it necessary to make tradeoffs between the quality of recorded video and the amount of uplink bandwidth available ?

Not with Boundless' system. Boundless has a distributed architecture where all video is recorded internally continuously, regardless of the speed of any wide area network used to remotely access the video server. No distant NVR or recording server is used. It's called *recording at the edge of the network*.

Since the recording is internal, multiple members of a task force can remotely access the recorded video as easily as they remotely access live video.

Q10) How quickly can Boundless' recorded video be accessed remotely ?

Often in only a few seconds. Boundless has developed its *hyper rapid access video file system* so that exact segments of recorded video can be accessed remotely quickly, without wasting time sending unwanted video, and without wasting time of our video server parsing a large file to find the starting point desired. The higher the data rate the video was recorded, and the slower the uplink, the longer it takes to move each video clip over the air.

In addition, recorded video from as recently as five seconds ago can be accessed remotely in a few seconds. With such a short delay, we call it *time-shifted video*. With continuous internal recording with better quality than can be sent live, and such rapid access to the recorded video, it is not necessary to continuously send the highest quality video over the air when a site is being actively watched. And, multiple members of a task force can remotely access the recorded video as easily as they view live video.

Another use of Boundless' recorded video streams with low and medium resolution is to remotely review recorded video over large time durations at as much as 8X normal speed. For example, depending on the speed of the uplink from the video server, the highest quality video might only be viewable at 1/2 of normal speed as it is being fetched from the video server, while lower resolution video streams, with their lower recorded data rates, may be viewable at 8X normal speed. Thus reviewing an hour's best quality video would require 2 hours, while reviewing lower quality video would only require 7.5 minutes – a 16:1 speedup. Once the point in time where closer attention to detail is required, one can choose to view the highest quality recorded video, starting from the exact frame selected by viewing the lower quality video.

All video viewed recorded in Boundless' *Control Panel* viewing software is cached (copied to) the hard drive of the PC doing the viewing. It can be archived from this cache, and, any subsequent viewing of it on that PC can be viewed at 1/8X to normal to 8X speed since the recorded video is being read from the PC's hard drive.

Q11) What happens to the internally recorded video once the hard drive is full ?

The oldest recorded video is overwritten unless, after some video has been recorded, we reconfigure the video server while it's in the field to protect the earlier recorded video, reducing the amount of storage space for new video to be recorded.

Q12) How much video can be recorded in each Boundless' video server ?

It depends on the capacity of the hard drive in the unit, and the way the various video streams are configured. For round numbers and rough estimate – not a guarantee – 250 GB can typically store about one week's worth of video from two cameras. Boundless can equip its outdoor and mobile video servers with up to 1,000 GB of 2.5" magnetic storage.

Q13) Do Boundless' video servers have motion-search capability ?

Yes. Hours of video can be searched in seconds using a search engine that runs on the video server, avoiding sending the video over the air to be searched. A graph is produced that shows the relative amount of motion over time, not just a list of when motion started and stopped. One can gauge the type of subject (person, vehicle, etc.) based on the shape of the motion graph at each point in time.

The entire video frame can be searched, or portions (zones) of each frame can be searched, where the zones are specified after the video has already been recorded. Zone-based motion searching is slower than whole-frame based searching.

Recorded video can be accessed quickly and easily. One places a recorded video stream on the screen in Boundless' *Control Panel* viewing software, then double-clicks on a point on the motion graph to instantly jump to the selected point in time. This makes use of Boundless' *Hyper Rapid Access Video File System*.

Q14) Can Boundless' video servers detect motion and send an alert ?

Yes. Boundless has an optional software system called its *Rapid Notification System* that is coupled to Boundless' zoned motion detection system. Its key features are that it:

- a) avoids e-mail and text-message delays, enabling messages containing live video, not just a snapshot, to be received within 5 seconds,
- b) enables live and recorded video – not just a snapshot – to be viewed in a web browser without requiring the installation of any software on the viewing device,
- c) does not require the viewing device to have a mobile phone number, and
- d) enables dozens of viewers to see the same video at the same time without any added burden on the uplink from Boundless' mobile or outdoor video server.

Boundless also has the ability to discriminate motion in three dimensions, to minimize false alarms, but the details are beyond this document.

Q15) Why do Boundless' outdoor video servers typically have two PTZ cameras instead of one ?

It solves the “where do I point the camera” problem. One PTZ camera, usually with 10X optical zoom, is typically used to give a wide-angle, situation-assessment view so you know where to

point the other camera when you are viewing live video. The second PTZ camera, usually with 18X to 36X optical zoom and frame integration for superior low-light capability, depending on the option purchased, is typically used to give a simultaneous, close-up view. Both cameras can be remotely controlled and viewed live. Both are continuously internally recorded with better quality than can be sent live, and the recorded video can be viewed remotely.

Q16) Is it difficult to remotely precisely control a PTZ camera via a cellular network ?

Yes, unless a special technique is used to control it. Boundless has developed and uses a special technique. It can also remotely control the On-Screen Display in CCTV PTZ cameras.

It's easy to interactively precisely control a PTZ camera that you have a wired or LAN connection to. The problem is when you need to move the camera's live video over a wide area network where packet delays and packet losses are thousands of times greater than on a wired network. And, movement of the camera causes massive changes in the scene, requiring much higher data rates than when the camera's view is stationary.

We have video streams that are especially selected for viewing from moving cameras. We also have a graphical user interface to control PTZ cameras that allows the movement of the camera and lens to be "nudged" just a little, without relying on the user to try to start and stop the movement of the camera.

We also have a PTZ user interface that's intended for use in a Firefox and like browser on certain smartphones, where you only have one page open at a time. We invisibly overlay control of the PTZ camera on top of the live video. The further you click the video from the center of the video window, the faster and longer the camera moves in that direction.

Q17) How is Boundless' *Control Panel* viewing software used ?

That is a document onto itself. Here are a few highlights.

There's a list of a given customer's active Boundless' video server sites, each with its own meaningful site name that is chosen by the customer. Multiple Boundless' video servers can be organized as a single site. You expand the name of a site, and you get the name of its cameras. You expand the name of a camera, and you get its many different video streams.

You have a viewing area that you can divide and combine a multitude of ways. You drag and drop a video stream into a window in the viewing area. The video is viewed live if the Live tab is selected when the stream is dragged and dropped. The video is viewed recorded if the Recorded tab is selected when the stream is dragged and dropped. You can select one or more windows and change them from live to recorded or vice-versa.

You can define sessions to recall the current organization of the screen, the video streams in it, the live or recorded state of each video stream, and the time stamp of each recorded video stream. One can easily return to the exact frame with which recorded video was viewed, provided that recorded video is still available on the video server, or is stored in disk cache.

You control PTZ cameras by placing a video stream on screen, selecting it, and clicking the PTZ button. A web page on the video server that controls the selected PTZ camera will open in your web browser. Multiple PTZ control pages can be open simultaneously.

Q18) How much work does an IT department have to do to use Boundless' video servers ?

Usually none. Boundless' outdoor and mobile video servers are fully custom configured and tested. A small amount of assistance may be required to install Boundless' *Control Panel* live and recorded viewing, and motion searching, software on a PC.

Q19) Do Boundless' video servers support dynamic IP addresses ?

Yes. A service fee may be involved because we do not use public DNS servers, which we believe may be subject to cyber attack.

Q20) Do Boundless' video servers keep accurate time ?

Yes, if a Network Time Protocol Server on the Internet can be accessed.

Q21) Does Boundless have various models of outdoor video servers ?

Yes. All have our ultra low bandwidth, *Multi-Stream Video Server* built in. It captures video from CCTV and/or optionally IP-cameras, decodes video from IP-cameras, forms many different digital video streams simultaneously for each camera, compresses all video streams with MPEG-4, records those video streams internally, and handles communications over wide area networks, among many other functions.

We have outdoor models with two built-in PTZ cameras, or none. Some models are covert, with the two built-in cameras hidden from view, while other models have exposed camera domes for a wider field of view. Various amounts of internal recording are available. Models without internal cameras have the lowest power dissipation and are best suited for being solar-powered.

We also have models for use in vehicles. They handle up to four CCTV cameras, including PTZ cameras, and optionally, IP-cameras as described above.

Q22) What video compression does Boundless use ?

Boundless uses highly optimized MPEG-4 using code that we wrote, giving us many parameters that enable us to control its operation in great detail. For example, a video stream that is normally viewed live uses parameters that reduce the data rate in exchange for increased blurring of moving objects, while the highest resolution video stream that is normally viewed recorded will have parameters that make each frame as sharp as possible.

Q23) Doesn't MPEG-4 produce broken images sometimes, in which case MJPEG images are better for storage, even if the files are much bigger ?

No. Many IP-cameras use MPEG-4 and their video, like that of digital TV's, is often hard to connect to and drops portions of the images. However, the problem is the Internet protocol used to send the MPEG-4, not MPEG-4 itself. Many IP-cameras use the Real Time Streaming Protocol (RTSP), which allows portions of the video streams to drop out without replacing them, resulting in the loss of parts of the frame. The use of different Internet protocols avoids this.

Boundless avoids this problem by not using streaming protocols. In addition, Boundless records video internal to its video servers so that high quality recording is provided regardless of any problems with the wide area network being used to access them.

Q24) How does H.264 compare to MPEG-4 for video compression ?

It depends on what one uses the video for. If one is producing well-illuminated, i.e., having a high, signal-to-noise ratio, live entertainment video at high frame rates for YouTube, then H.264 may be a better choice, having possibly 30% less bandwidth. But if one is capturing public safety surveillance video, where each and every individual frame must be as sharp as possible because one is likely to pause individual frames, and where illumination may be poor, which produces a low, signal-to-noise ratio, because images are captured at night, and where frame rates may be lower than entertainment video, in which case every frame is more significant, then we believe MPEG-4 is a better choice, despite the many video surveillance companies adopting H.264.

Q25) Does Boundless support viewing video on a smartphone ?

Yes, but only with the addition of Boundless' optional *Event Broadcast Server*.

Many companies allow one to point a web browser at a web server in their IP-cameras and view video on a smartphone, but often with the requirement that a custom application must be loaded into the smartphone. There are several problems with this approach:

- (1) it requires a lot of uplink bandwidth since each viewer requires a different copy of the video stream,
- (2) it puts a large processing load on the processor in the IP-camera, possibly reducing the ability of the camera to handle video for everyone, and
- (3) if a custom executable must be loaded into the viewing device, it exposes the viewing device to cyber-security issues, and a number of government agencies have forbidden this.

With Boundless' optional *Event Broadcast Server*, our live and recorded video can be viewed in a web browser on a wide range of devices, without requiring the installation of any software on the viewing device. In addition, many users can view the same video at the same time with only a single load on the uplink from the video server.

Note: Boundless' video, when viewed in a browser, is not as sharp, or have as high a frame rate, as video viewed in Boundless' *Control Panel* viewing software that runs on a PC. This is the price one pays to have the convenience of viewing video in a web browser on a wide range of devices, without requiring the installation of any custom software on the viewing device.

Q26) Is it difficult to put a hard drive in outdoor equipment ?

Yes, it's difficult to do well. Magnetic hard drives have a huge cost advantage, about 20:1 per unit storage, compared to solid state disks. Magnetic hard drives, like solid state disks, have a limited range of operating temperatures, unless much more expensive, lower capacity units are used.

Magnetic hard drives also require a certain range of operating air pressure. This is because the tiny disk heads fly, like an airplane wing, over a rapidly spinning disk. If the internal air pressure is too low, they crash, destroying the disk. If the internal air pressure is too high, they fly to high to read and write data. The problem with building outdoor equipment is that you need to protect internal electronic devices from environmental pollutants, salt fog, and dust. If you just blow outside air through the unit to cool it, the internal equipment won't last. If you just seal the unit, not only can't you blow outside air through it, but the internal air pressure will rise when the unit heats up, exceeding the allowed maximum air pressure and the disk won't work.

This is why Boundless developed outdoor equipment that uses Boundless' thermal management system with Boundless' inner-sealed, dual-chamber heat exchanger, plus salt-fog rated fan(s) exposed to the atmosphere, and a pressure-relieved hard drive.

Q27) What is a dual-chamber heat exchanger that Boundless talks about in its outdoor video servers ?

It is our means of keeping the cameras and video server cooler in warm weather, and warmer in cold weather, without exposing them to moisture, environmental pollutants and dust. Our outdoor video servers have two chambers, a sealed, pressure-relieved, inner chamber and an outer chamber. The outer chamber is exposed to the environment, although protected from the sun and rain. The outer chamber has fans that are rated for use in salt-fog, a corrosive environment, to move exterior air over the heat exchanger to remove heat when the air is cooler than the heat exchanger. It helps keep our equipment warmer in cool weather because our thermal management system does not exhaust much heat via the heat exchanger at that time.

Q28) Does Boundless use encryption and revokable security certificates ?

Yes, as an option. The communication of our live and recorded video over a wide area network via our VPN is encrypted when our tunneling option and tunneling server are used.

Each video server has its own unique security certificate. It can be revoked if the video server is compromised, stopping the video server from using our VPN, and stopping anyone who has unauthorized possession of the video server from accessing our VPN via the video server.

PC's containing our *Control Panel* viewing software can also use our VPN to access our video servers and have a unique security certificate that can be revoked if the PC is compromised.

Q29) Does Boundless encrypt recorded video on its video servers' hard drives ?

Yes, as an option. It is done dynamically to protect against theft of the video server and direct access to, and copying of, its hard drive. We can't discuss details here.

Q30) What kinds of cameras do Boundless' video servers use ?

It depends on the model of our video server and the options purchased. Boundless' video servers handle CCTV cameras when we install a video capture card in the video server. Our most recent video servers can optionally support a mix of CCTV and IP cameras, or just one kind of camera or the other. See the next question.

Q31) What kinds of IP-cameras do Boundless' video servers support ?

Boundless' video servers optionally support IP-cameras that use HTTP or RTSP to carry the video, and M-JPEG, MPEG-4 and H.264 video. An example of a supported camera is the Sony SNC-RZ50N using MPEG-4 over RTSP or HTTP.

Note: When one of Boundless' video servers supports IP cameras, the video server does not function merely as a Network Video Recorder (NVR) or Streaming Server. Our video server decodes the video from the IP camera and then runs it through our multi-stream-formation and recording system. This provides the same wide range of resolutions, frame rates, data rates (typically over a 100:1 range), and compression factors as we do for CCTV cameras, making it easy to remotely obtain video from an IP-camera over a wide area network. And, the video is recorded internally, with better quality than can be sent live. Video can thus be sent from a wireless IP camera at its best possible quality to our nearby video server, with a much higher data rate than can be supported by a wide area network. The video from the IP-camera is received and processed by our video server, producing video streams that are handled easily by a wide area network. This will become increasingly important as the number of high definition IP cameras grows.

Q32) Do Boundless' video servers require a public IP address to be accessed from the Internet or other wide area network ?

Not when our optional tunneling server is used. When our optional *Event Broadcast Server with Tunneling* is used, our video servers can be installed behind firewalls that block remote access from the Internet to other servers. Users would access our video servers via the *Event Broadcast Server*. Examples of such firewalls are routers on LAN's, as well as firewalls between certain cellular networks and the Internet. Most cellular networks outside of North America, as well as cellular networks from AT&T and T-Mobile in the USA, have firewalls between the cellular network and the Internet. Such firewalls do not affect so-called mobile-originated traffic, such as a PC accessing Google, but stop users on the Internet from accessing servers behind the firewall.

Q33) Can Boundless' live and recorded video be integrated into other systems ?

Yes. Unlike others, we use common web-based programming techniques so that our live and recorded video, and our PTZ-camera control, can be integrated into other browser-based systems.

Q34) What applications can benefit from running in Boundless' video servers ?

Video analytics and control of access control and monitoring devices, to name a few. Messages from external devices can make use of Boundless' VPN and *Rapid Event Notification System*.

Q35) Is Boundless able to manage its video servers while they're in the field ?

Yes, securely via Boundless' VPN, so long as the video servers have a connection to the Internet. The VPN is also used to send maintenance e-mails, such as disk status messages, and error reports to Boundless, avoiding the need to configure each video server to use the e-mail servers required by the particular Internet Service Provider it is using.

Each video server has its own name, and its own e-mail address at BoundlessSecurity.com for sending messages.

Q36) Where has Boundless had experience with its systems ?

Boundless has had experience with its ultra low bandwidth system on cellular networks on five continents. Since most cellular networks outside of North America are so-called mobile-originated networks that use GSM technology, as opposed to the mobile-terminated networks in North America that use CDMA technology, Boundless' optional tunneling enables all kinds of cellular networks to be used.

Boundless has had experience with Iridium (the world's largest mesh network), Inmarsat and VSAT satellite networks, WiFi and WiMAX wireless networks, and wireless mesh networks.

Q37) Does Boundless' system require use of the Internet ?

Not for certain public safety and high-security commercial applications. Private wide area IP-data networks can also be used, although they should support certain services such as network time protocol servers, and may require a Boundless' middleware server on them to provide certain other services.

Q38) How are Boundless' video servers constructed ?

Boundless' core technology is its software, which Boundless has developed over the years. Boundless builds its video servers from computer industry standard components, and installs and configures its software and Linux to run on them. This provides a very flexible product line and enables Boundless to add additional features, such as VPN's, encryption and analytics, on that

same platform, and to quickly take advantage of continuous improvements in very high-volume computer components, such as mainboards / motherboards.

Some of Boundless' software runs on so-called *middleware servers* (they are in the middle between the video server and the viewer), which Boundless sells turn-key, or for which Boundless can install its software on the "cloud" or dedicated-server hosting services.

Boundless' outdoor video servers use thermal and power management systems designed and built by Boundless.

Q39) Where does Boundless design and build its video servers ?

In the USA. Some foreign components are used.

Q40) Does Boundless license its proprietary software and supporting Intellectual Property to OEMs ?

Boundless has an OEM program.

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